9/5/2013

B.E (EXTC) Sem VII (R)
Discrete Time Signal Processing

ws-Con-2013-1

Con. 7541-13. **(REVISED COURSE)** **GS-5332**

(3 Hours) **[Total Marks : 100**

N. B.

1. *Question no. 1 is compulsory.*
2. *Answer any four out of the remaining six questions.*
3. *Assumption made should be clearly stated.*
4. *Assume any suitable data wherever required but justify the same.*
5. *Figures to the right indicate marks.*
6. *Illustrate the answers with sketches wherever required.*
7. *Answer to the questions should be grouped and written together*
8. *Use Blue/Black ball ink pen to write answers. Use of pencil should be done only to draw sketches and graphs*

Q.1 (a) Assume that a complex multiplier takes 1 micro sec to perform one multiplication and that the amount of time to compute a DFT is determined by the amount of time to perform all the multiplications. [5]

i. How much time does it take to compute a 1024 point DFT directly?
ii. How much time is required is FFT is used?

(b) Let h[n] be the unit impulse response of a Low Pass filter with a cutoff frequency ω_c, what type of filter has a unit sample response $g[n] = (-1)^n h[n]$. [5]

(c) A two pole low pass filter has the system function $H(z) = \frac{b_0}{(1-pz^{-1})^2}$ Determine the values of b_0 and p such that the frequency response $H(\omega)$ satisfies the condition $|H(0)| = 1$ and $\left|H\left(\frac{\pi}{4}\right)^2\right| = \frac{1}{2}$ [5]

(d) Consider filter with transfer function. Identify the type of filter and justify it. [5]

$$H(z) = \frac{z^{-1} - a}{1 - az^{-1}}$$

Q.2.(a) The unit sample response of a system is h(n)={3,2,1} use overlap-add method of linear filtering to determine output sequence for the repeating input sequence x[n] = {2,0,-2,0,2,1,0,-2,-1,0} 10

(b) For a given sequence x(n) ={2,0,0,1}, perform following operations: 10

i. Find out the 4 point DFT of x(n)
ii. Plot x(n), its periodic extension $x_p(n)$ and $x_p(n-3)$
iii. Find out 4 point DFT of $x_p(n-3)$
iv. Add phase angle in (i) with factor - $\left[\frac{2\pi rk}{N}\right]$ where N=4, r=3 k=0,1,2,3
v. Comment on the result you had in point (i) and (ii)

Q.3.(a) The transfer function of discrete time causal system is given below : 10

$$H(z) = \frac{1 - z^{-1}}{1 - 0.2z^{-1} - 0.15z^{-2}}$$

i. Find the difference equation
ii. Draw cascade and parallel realization
iii. Show pole-zero diagram and then find magnitude at $\omega = 0$ and $\omega = \pi$
iv. Calculate the impulse response of the system.

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(b) Obtain the lattice realization for the system : 10

$$H(z) = \frac{1 + 3z^{-1} + 3z^{-2} + z^{-3}}{1 + \frac{3}{4}z^{-1} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-3}}$$

Q.4.(a) What is a linear phase filter? What conditions are to be satisfied by the impulse response of an FIR system in order to have a linear phase? Plot and justify compulsory zero locations for symmetric even antisymmetric even and antisymmetric odd FIR filters 10

(b) Determine the zeros of be following FIR systems and indicate whether the system is minimum phase, maximum phase, or mixed phase 10

$H_1(z) = 6 + z^{-1} - z^{-2}$

$H_2(z) = 1 - z^{-1} - 6z^{-2}$

$H_1(z) = 1 - \frac{5}{2}z^{-1} - \frac{3}{2}z^{-2}$

$H_1(z) = 1 + \frac{5}{3}z^{-1} - \frac{2}{3}z^{-2}$

Comment on the stability of the minimum and maximum phase system

Q.5 (a) A digital low pass filter is required to meet the following specifications : 10

Pass band ripple	:	≤ 1dB
Pass band edge	:	4 KHz
Stop band attenuation	:	≥ 40 dB
Stop band edge	:	8 KHz
Sampling rate	:	24 KHz

Find order, cutoff frequency and pole locations for Butterworth filter using bilinear transformation

(b) Design an FIR digital filter to approximate an ideal low-pass filter with passband gain of unity, cut-off frequency of 950 Hz and working at a sampling ftequency of Fs = 5000 Hz. The length of the impulse response should be 5. Use a rectangular window. 10

Q.6(a) Explain the need of a low pass filter with a decimator and mathematically prove that $\omega_y = \omega_x D$ 10

(b) Why is the direct form FIR structure for a multirate system inefficient? Explain with neat diagrsms how this inefficiency is overdone in implementing a decimator and an interpolator. 10

Q.7 Write short notes (any four); 20

i. DTMF detection using Goertzel algorithm
ii. Filter banks
iii. Comparison of FIR and IIR filters
iv. Split radix FFT
v. Optimum Equiripple Linear phase FIR filter design